

ENSEMBLE Models

Updated: 12 July 2001

Objective

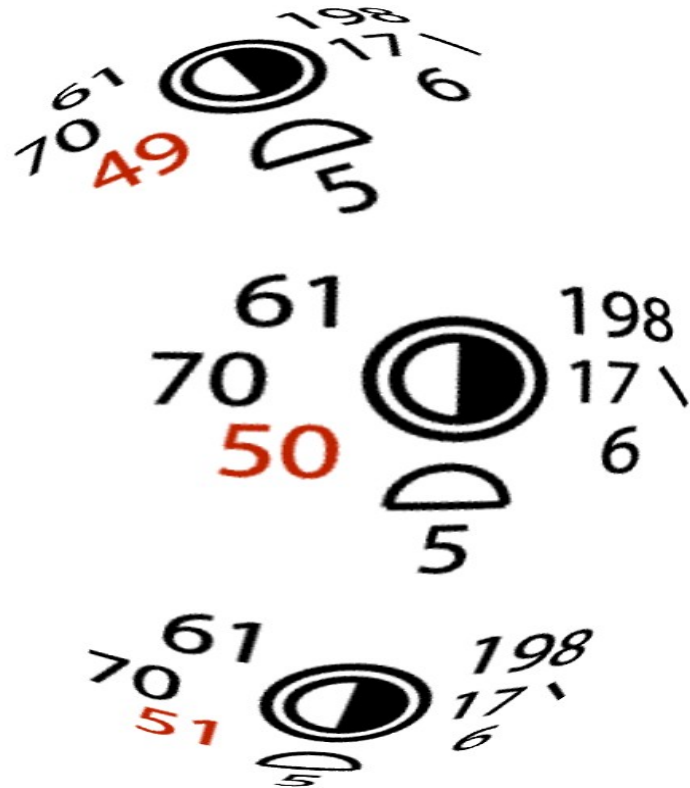
- Given access to meteorological data, interpret numerical weather prediction products IAW an evaluation checklist. Meas: PC/W

What is an Ensemble ?

- *An average from numerous runs, usually of the same model*
- *Same synoptic time!*
- *Has different starting point observation data*

Chaos Theory!

- *Randomly skewing the initial data fields*



Benefits...

- *Technique can remove model errors created from inaccurate starting data*
- *Provide the best guidance in the extended forecast period -- greater than six days*

Ensemble Forecasting

- **Major area of development for medium and extended range forecasting**
- **Defined as the process of introducing small perturbations to the initial conditions and studying the resultant collection (ensemble) of forecasts**
- **Small short range ensemble research is underway**

Current Activity

- **Ensemble forecasting began at ECMWF in 1992**
- **NCEP started testing ensemble forecasting in 1993 using the MRF**
- **FNMOOC has been preparing ensemble products since 1996**

Definitions

- *Ensemble* is a set of model solutions such that each solution (called a “member”) is initiated with a slightly different set of initial conditions
- The different members are created by introducing set of small perturbations to the initial conditions of a control forecast

Choice of Perturbations

- **Wish to chose perturbations that are similar to the size and distribution of rapidly growing errors (those that are responsible for the loss of model predictive skill)**
- **Random errors in the analysis will not grow rapidly since they are not organized dynamically**

Schematic representation

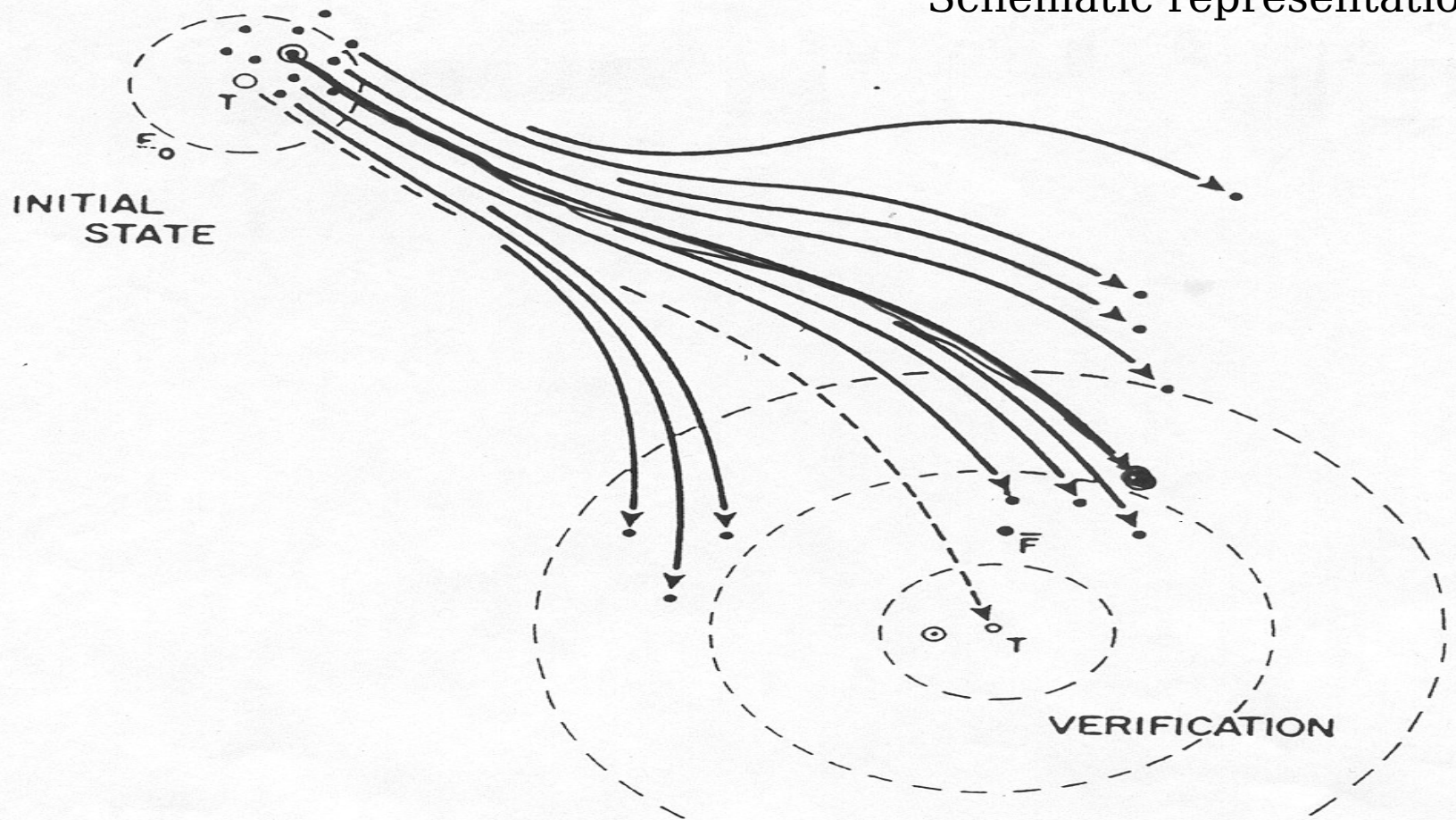
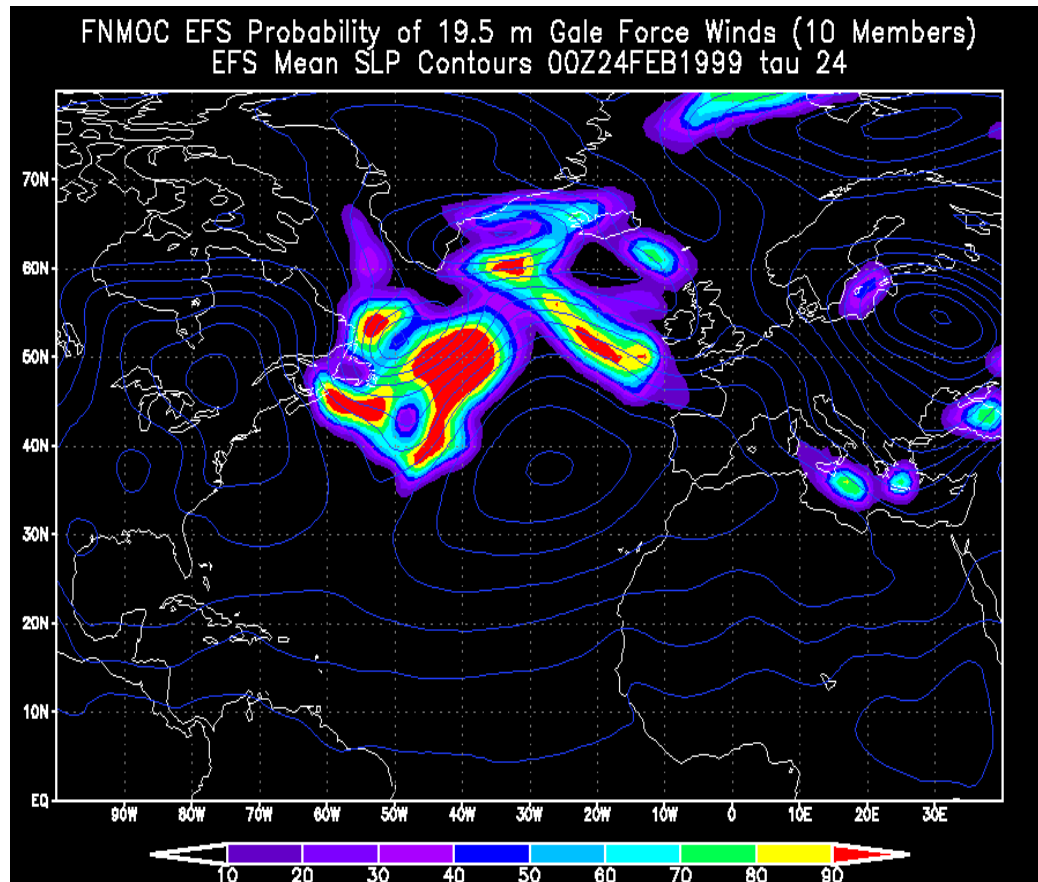


FIG. 1. Schematic representation of the evolution of members of a forecast ensemble in phase space, as indicated by the curved arrows. One individual forecast is highlighted by the circled dot. The open circle labeled "T" represents the true state of the atmosphere at both initial and verification times. The dashed circles, labeled " E_0 " at the initial time, is an indication of an acceptably good analysis or verification; "F" represents an average of the ensemble forecast members.

Ensemble Forecast Products

- **Ensemble Mean (will be more skillful than individual members)**
- **Ensemble Spread and Spaghetti Diagrams**
- **Ensemble Clusters**
- **Plume Diagrams**
- **Probability from Ensembles**

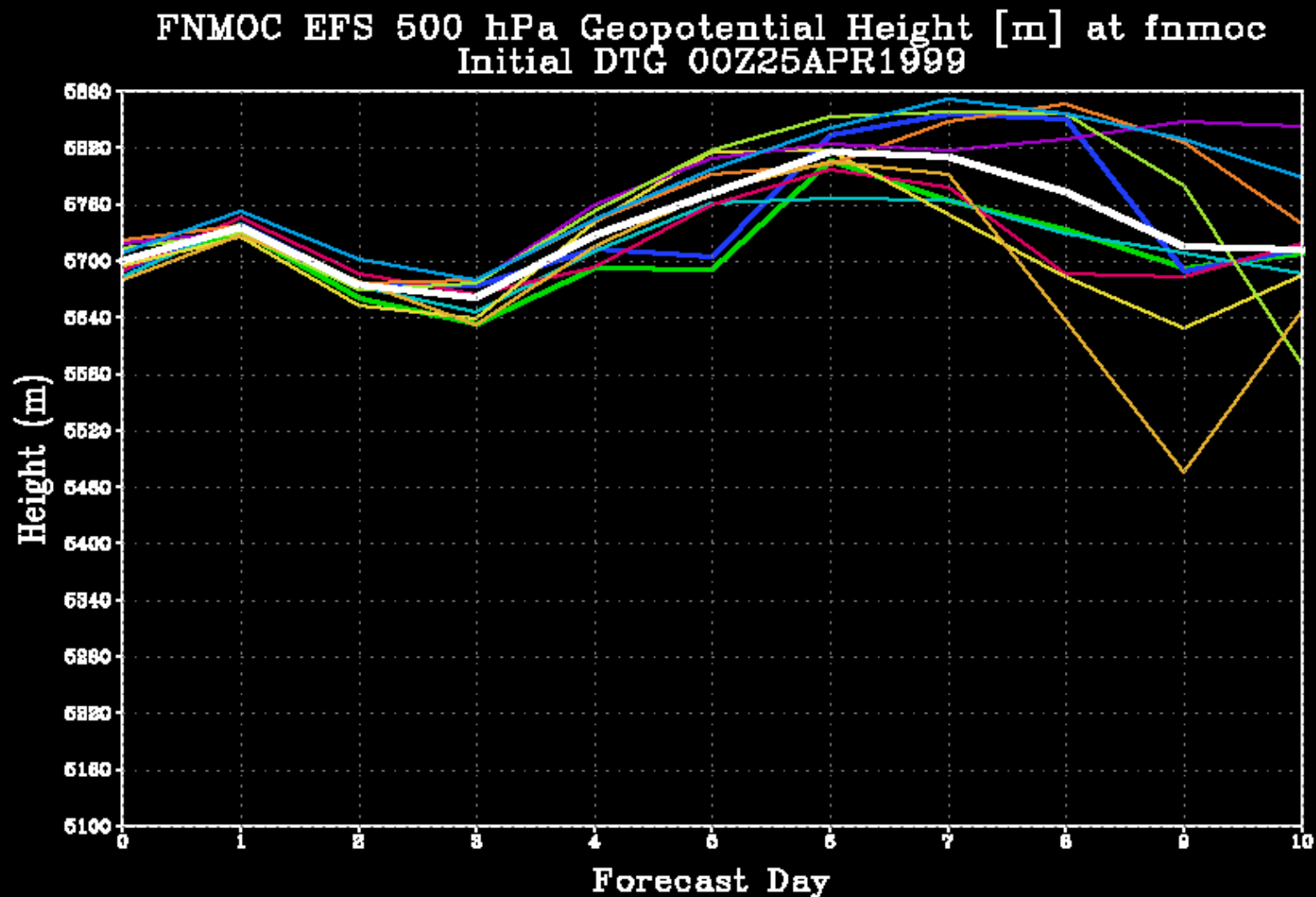
FNMOC's Ensemble Forecast System (EFS)



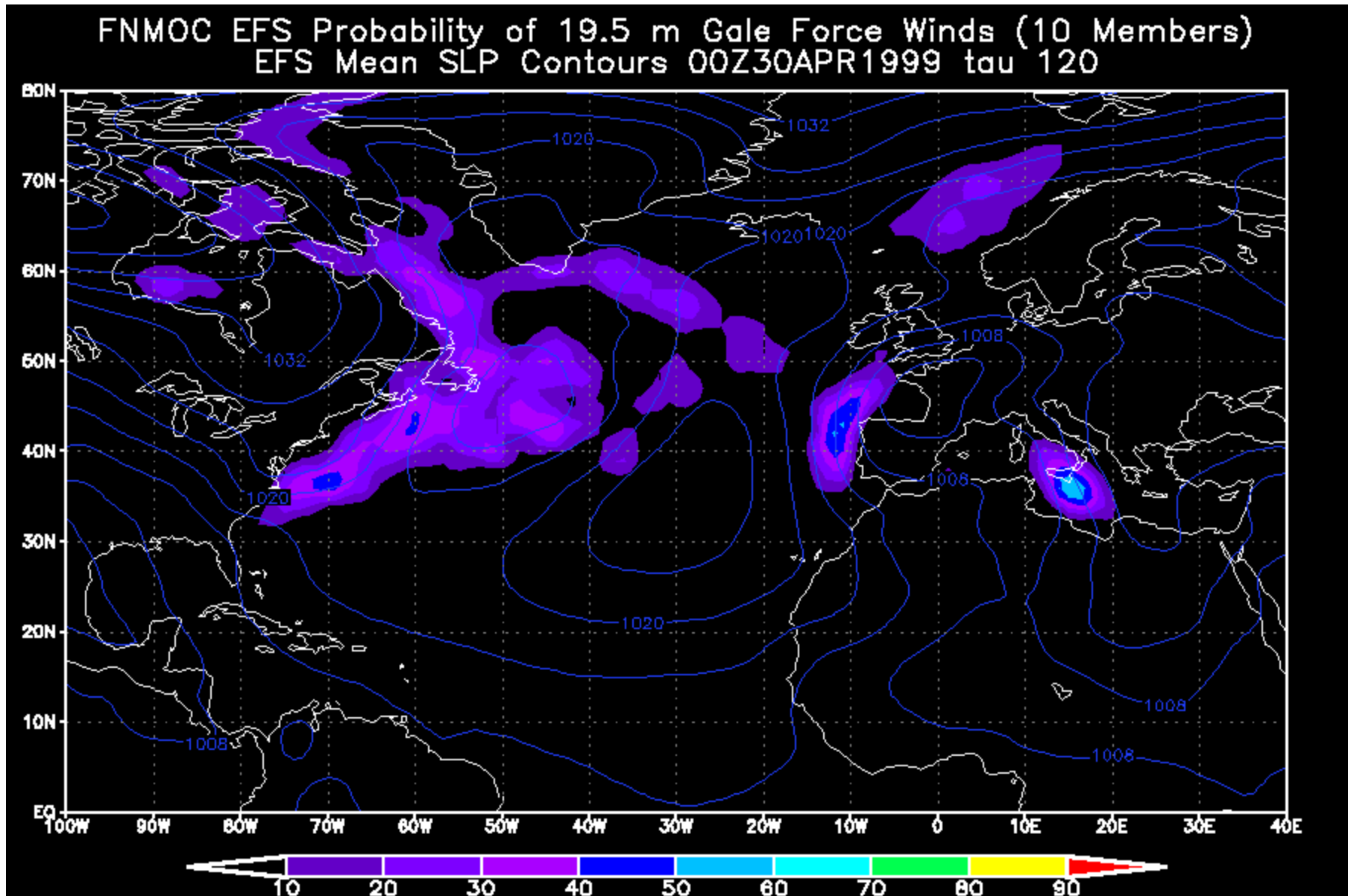
EFS probability of gale force 19.5 m winds at TAU 24 and MEAN SLP.

- ***10 Day forecasts produced by ten NOGAPS model forecasts***
- ***Average of forecasts shows more skill than single higher resolution model***
- ***Available products include:***
 - ***Precipitation Probability***
 - ***Gale Probability***
 - ***500 hPa Single Contour***
 - ***500 hPa Initial Perturbation***
 - ***Plume displays***
- ***NLMOC Long Range Support Page***

Plume Chart Example

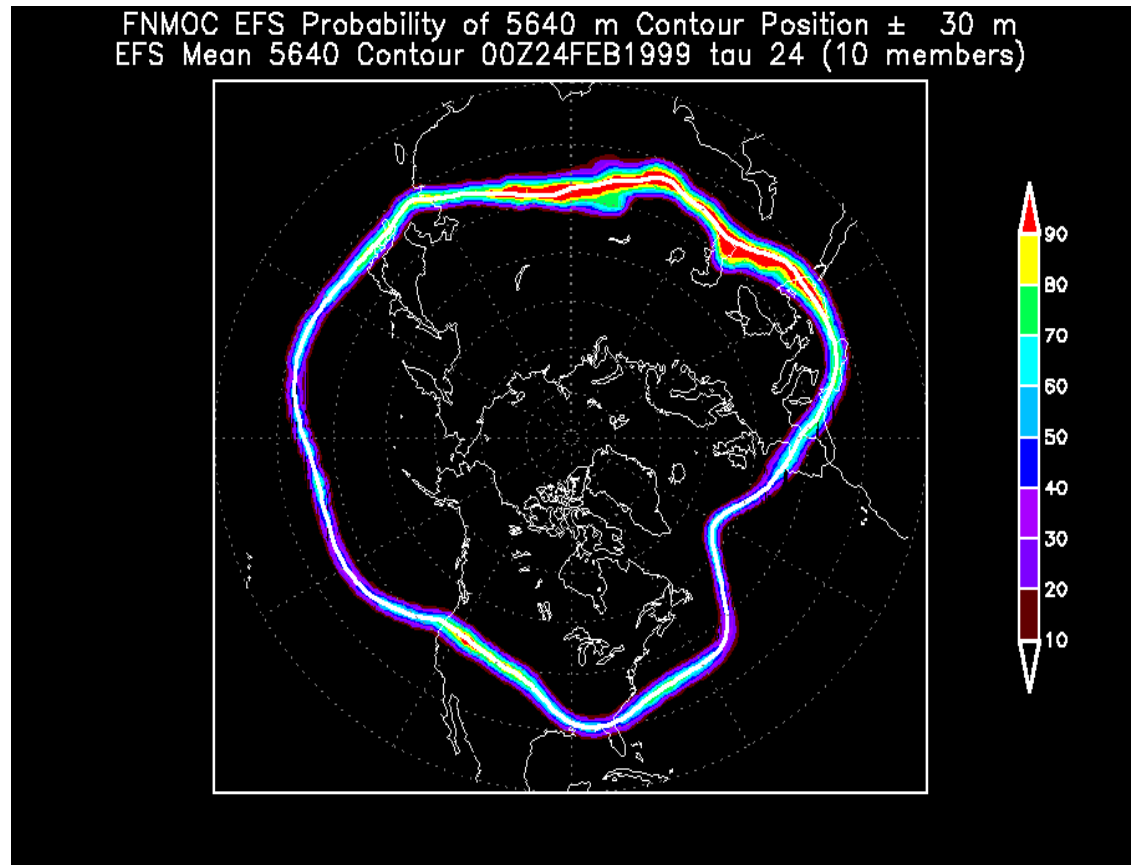


Gale Force Winds Example



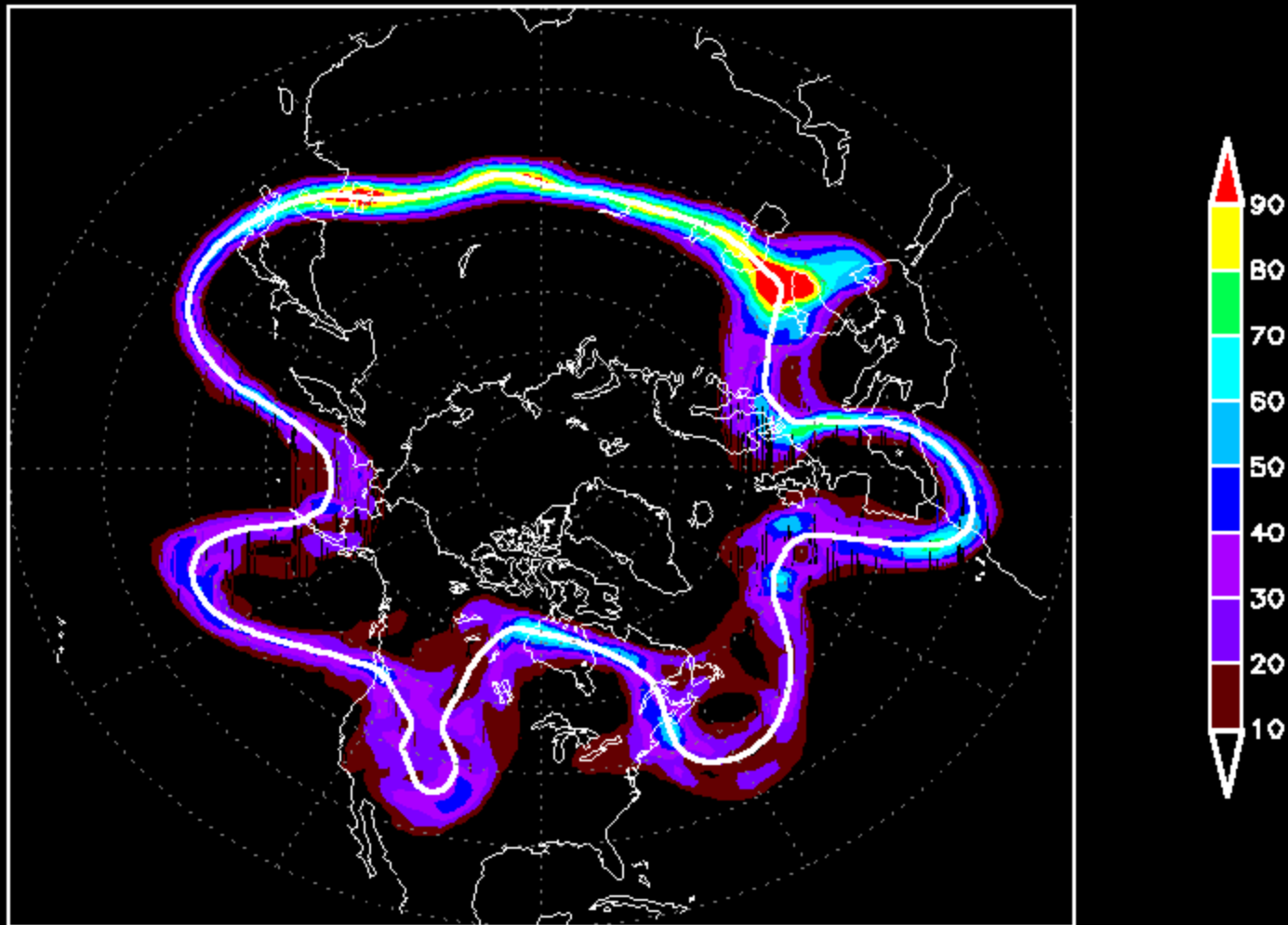
EFS 500 mb Single Contour Probability Display

- **One line of equal height is displayed**
- **The thinner the line the greater the agreement**



Single Contour Example 1

FNMOE EFS Probability of 5640 m Contour Position ± 30 m
EFS Mean 5640 Contour 00Z30APR1999 tau 120 (10 members)



5640 m Example 1



5640 m Example 2

Divergen
ce

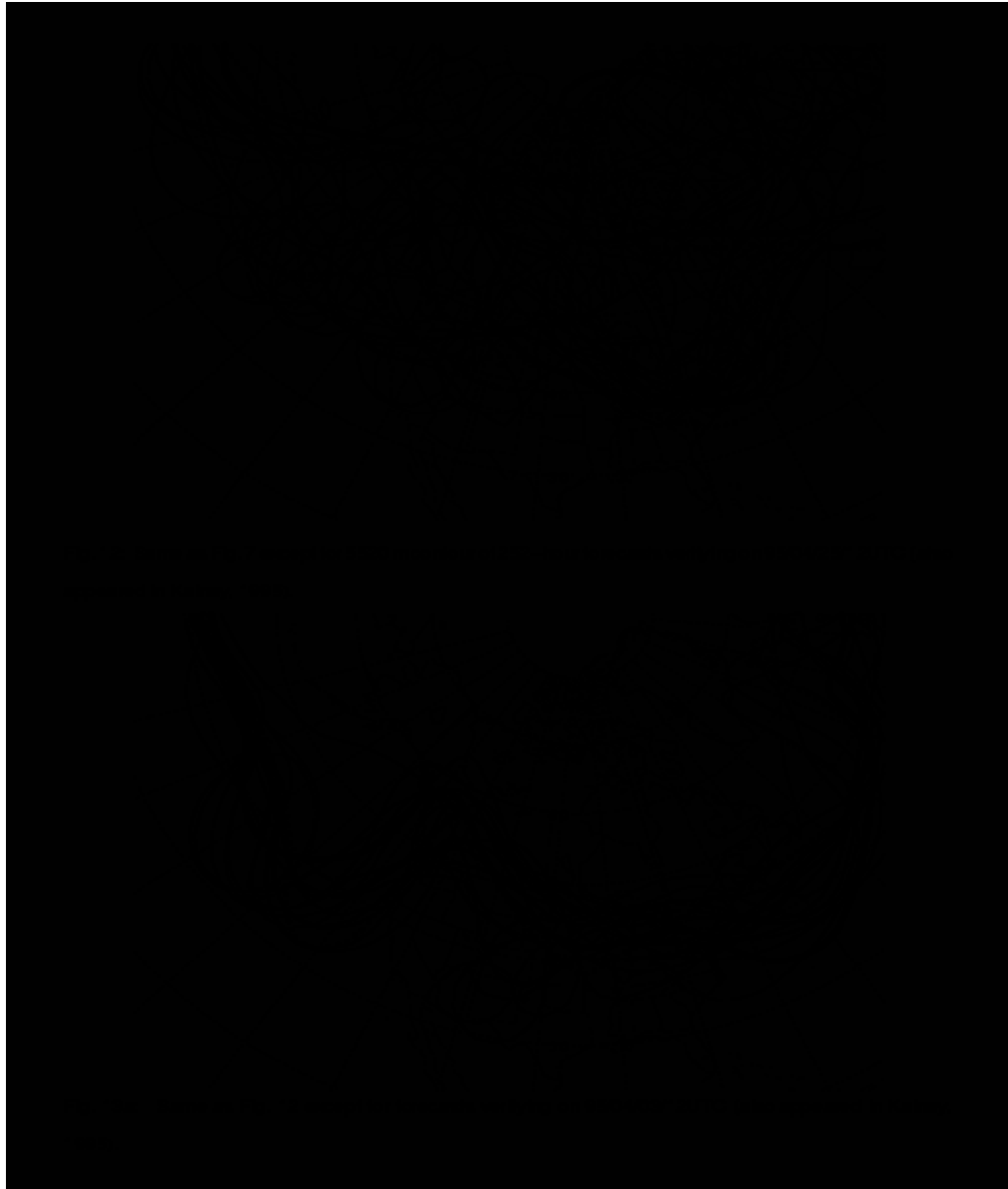
in short
range
ensemble
predictio
ns,

12 h, 36 h
and 84 h



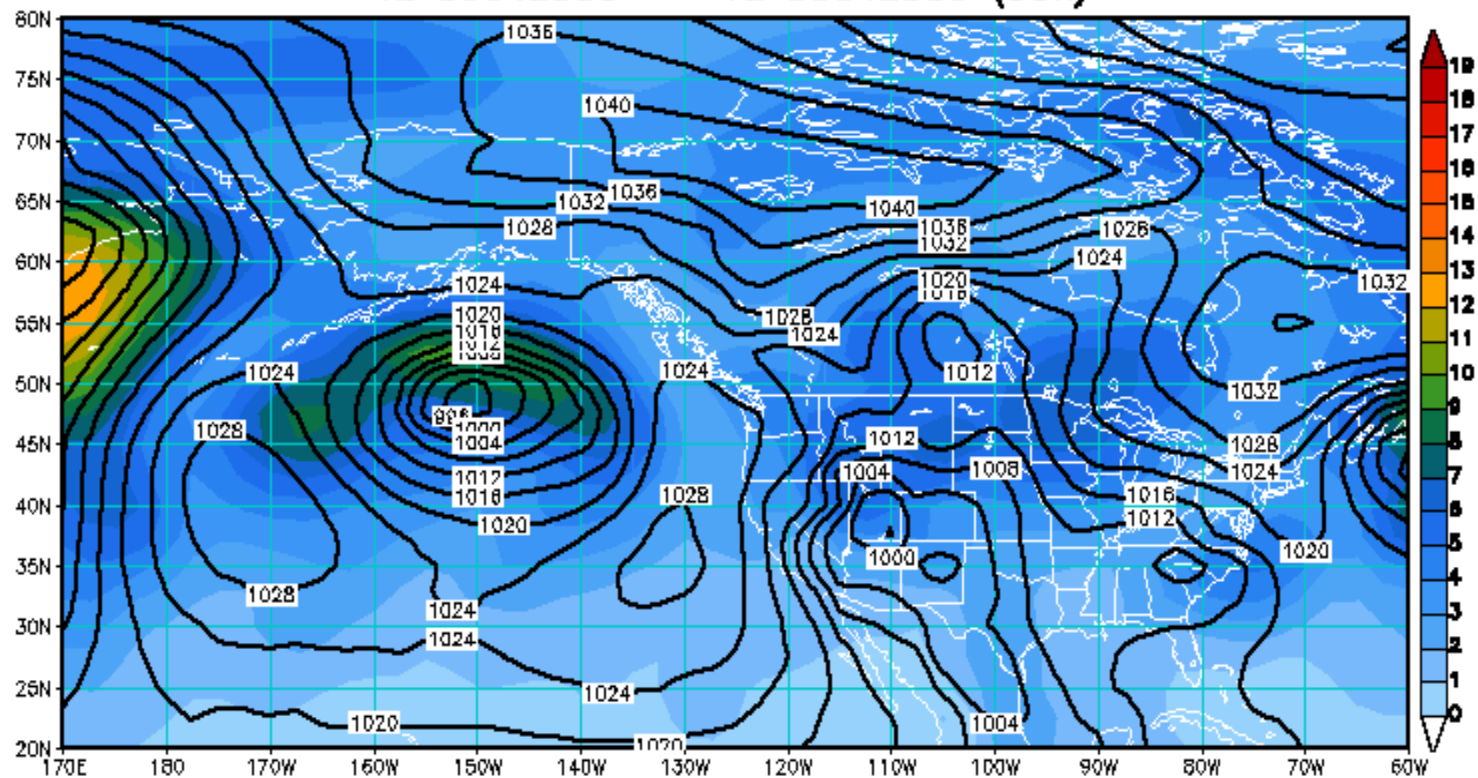
Spaghetti Chart Term Example

Two
Example
s
of 10.5
Ensembl
e
Forecast
s



Mean Sea Level Pressure Example

NCEP MSLP Ensemble Spread (shaded, mb)
MRF MSLP (contours, mb)
it: 99042500 vt: 99042900 (96h)



Examples of Forecasts

- **NCEP Ensembles**

- www.cdc.noaa.gov/~map/maproom/ENS/ens.html#nh

- **FNMOC Ensembles**

- www.fnmoc.navy.mil